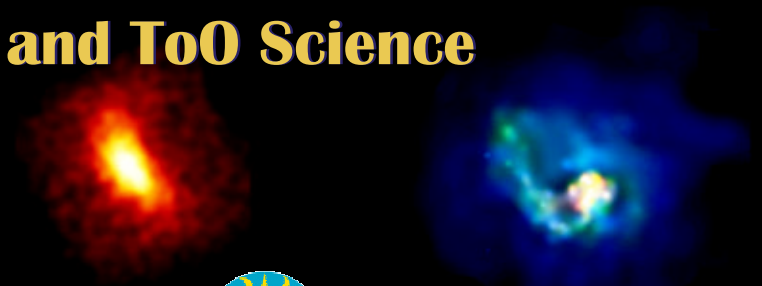
Con-X FST, November 19-20, 2003

Constellation X

The Constellation X-ray Mission



Sky Coverage Capabilities and ToO Science

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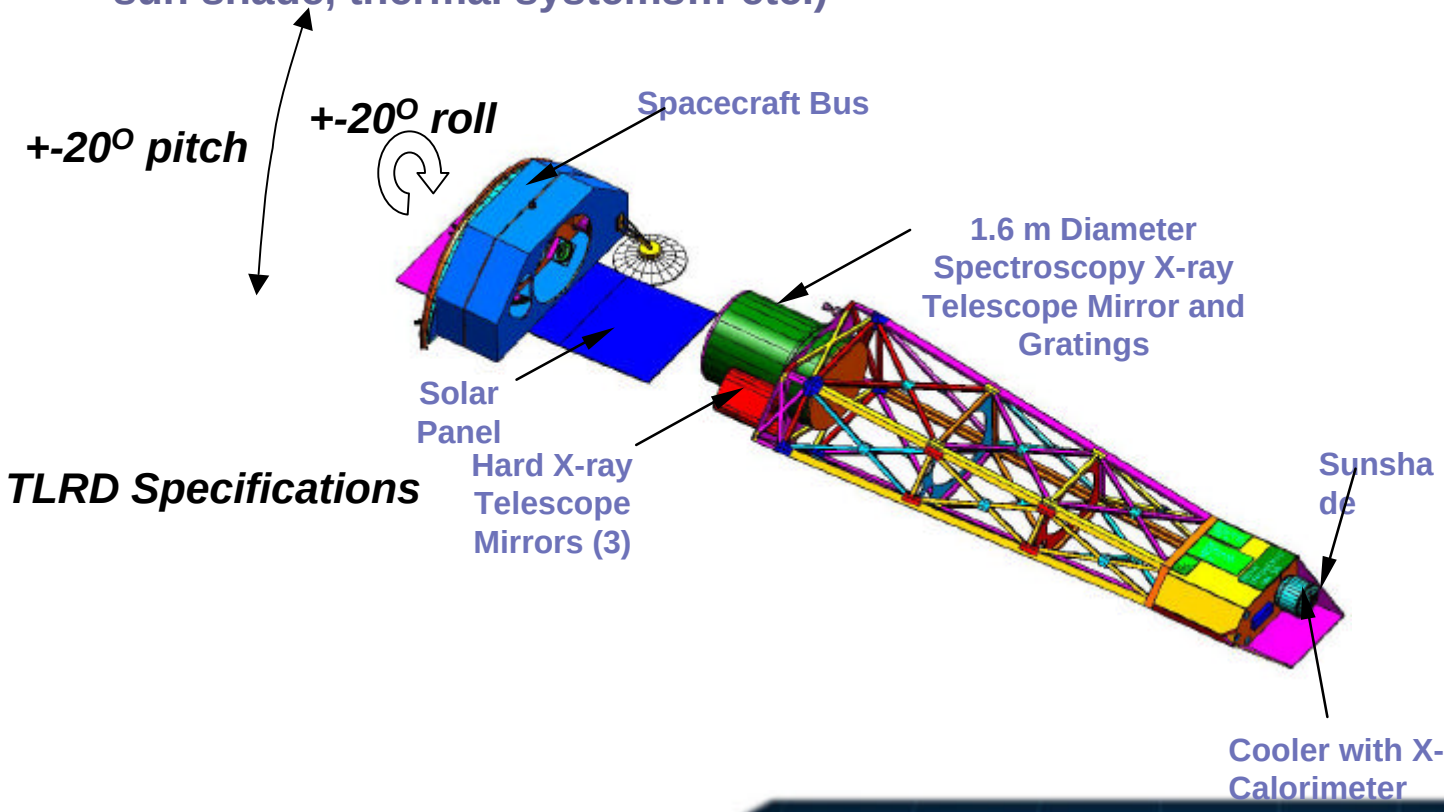
QUESTION:

- **What effects do the current instantaneous sky coverage specs have on ToO driven science?**
  - **Top Level Requirements Doc, ± 20^{O} roll, ± 20^{O} pitch = 34% sky (simultaneous)**
  - **Solar Arrays, Power System sized for this requirement (also, collimators, sun shade, thermal systems… etc.)**



How To Predict Number/Nature of ToOs?

- 1: ODRM – but somewhat incomplete with regards to ToOs in particular
- 2: Chandra Observing Catalog – what has been done that is relevant to Con-X? (Spectral Studies, not locations, jets, etc.)
- 3: XMM Observing Catalog – Compare to Chandra

XMM	Chandra
Pitch = ± 28^{O},	Pitch = 45^{O}->180^{O} (articulated SAs)
Sky Coverage = 47%	Sky Coverage = 85% (15% sun block)
Rate of ToOs?	Rate of ToOs?

ASSUME: ToOs uniformly distributed on sky; sky coverage = capacity to observe ToO

Numbers/Types of ToOs?

- 1: ODRM
  - Relativistic FeK lines in BHXN in outburst (Miller, Garcia).
    - Expect ~1 per year, Chandra (AO2-4) rate 1.3/year
  - X-raying the Hot IGM (Mathur, PKS2155-304/Blazar ToO?)
    - Chandra Obs of MKN421 (Nicastro) , rate 1/year, but Con-X can do 10s targets, 5-15s OVIII in 200ks. For IGM abundances high flux levels may be needed… Expect ~ few per year
    - ToO Observations of nearby SN1a/c (Hughes, Lewin, Kulkarni…)
    - Expect ~1 per year (within 10Mpc, Virgo). Chandra (AO3-4) rate = 4/year (within 30Mpc, GRB like)
    - Distant SN – 15'' PSF causes confusion with galaxy
  - That's all for ODRM (currently)

Number/Types of ToOs?

- **2: Chandra ToO Observations (not yet in ODRM)**
  - Accreting MSPs
    - Discovery rate 1/year, Chandra rate 1/year
  - Magnetars/SGR
    - Small population, Chandra rate 2/year
  - Spectra of X-ray Rich/OD GRBs
    - Discovery rate high, but trigger in Con-X era? Chandra rate (spectra) = 3.5/year.
  - CVs in outburst
    - 2.5/year with Chandra
  - NS Transients throughout decay – continued accretion (abundances?), heating/cooling of crust?
    - Aql X-1, RB, NS/XRT, targets limited – Chandra rate 1/year
  - Galactic Nova, Super-Soft Sources, others?

Numbers/Types of ToOs?

- **3: Compare XMM (28^{O} = 47%) and Chandra (=85%)**
  - **Chandra (AO3,AO4)**
    - **Total Number of ToOs + DDT = 75/year**
    - **Total Number of BHXN ToOs = 29/year, 7.5 distinct objects/year (Jets, Positions; only ~1/year for Broad Fe Lines)**
  - **XMM**
    - **Total Number of ToOs + DPS = 68/3.5 years = 19.4/year**
    - **Total Number of BHXN ToOs = 8/3.5years, 5 distinct objects/3.5 years**
    - **Average rate ~1/4 Chandra**
- **Lower XMM numbers may be partially due to sky coverage.**

Expected Con-X S Numbers of ToOs in 4-year Nominal Life?

- **BHXN Broad Fe Lines:**
  - ~1.4 = 1/year * 34% * 4 years
- **Hot IGM (Missing Baryons)**
  - ~1.4 = 1/year * 34% * 4 years FOR ToOs, abundances, do at lower fluxes?
- **Nearby SN:**
  - ~4.4, = 4/year * 34% * 4 years, confusion within Galaxy may limit z
- **Accreting MSPs:**
  - ~1.4 = 1/year * 34% * 4years
- **Magnetars/SGR**
  - ~2.8 = 2/year * 34% * 4 years
- **X-ray Rich/OD GRBs**
  - ~4.8 = 3.5/year * 34% * 4 years, but SWIFT may change our targets, trigger in 10y?
- **CVs in Outburst**
  - ~2.7 = 2/year * 34% * 4 years
- **Bursters Throughout Decay**
  - ~1.4, 1/years * 34% * 4 years

ANSWER:

- **Q: Does the current instantaneous sky coverage spec limit ToO driven science?**
- **A: Yes, for any ToO with < 2 targets/year. MISSION S**

  S ~ 1.4: Relativistic FeK lines in BHXN, HOT IGM (at highest fluxes), accreting MSPs, Busters throughout decay.

  S = 3 to 5: Nearby SN, Magnetars, CVs in outburst, OD/X-ray rich GRBs
- **Can we increase these S by 2x or more?**

Pitch Limits, Sky Coverage:

Pitch Range	Fraction of Sky	Fraction Solar Power
±20 degrees – spec	**34%**	**94%**
±30 degrees	**50%**	**87%**
±45 degrees	**71%**	**71%**

Roll Limits: **±20°** – simultaneous with ±20° pitch. At limit of 20° the solar power is down another 6% (= 1-cos(20)). IF we couple pitch and roll – allowing only 0 roll at maximum pitch – then power considerations alone will allow and extended pitch range (ie, arc-cos (cos(20)*cos(20)) = 28°

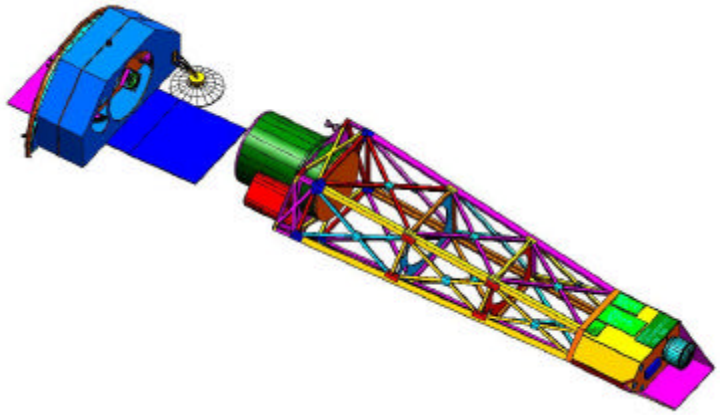
Extended Pitch Range	Fraction of Sky	Fraction Solar Power
±28 degrees – spec?	**47%**	**88%**
±35 degrees	**56%**	**77%**
±48 degrees	**75%**	**62%**

Impacts/Options of increasing pitch range?

- **Link Pitch and Roll, to allow 28^{O} pitch at 0^{O} roll**
  - **~40% increase in sky coverage, ToO numbers**
  - **No Impact on SAs, but impacts on Sun Shades, Thermal loading, operations**
- **Increase off-nominal Pitch angle to 48^{O} (or intermediate)**
  - **2.2x increase in sky coverage, ToO numbers**
  - **Require larger SAs, different shape (articulated? $$)**
    - **Modest increase? 88% power -> 62% power = 42% SA increase**
  - **Power System upgrades**
  - **Current SA size << than SpaceCraft size**

Expected S Numbers of ToOs with 48^{o} pitch = 2.2x

- BHXN Broad Fe Lines:
  - ~1.4 -> 3.1
- Hot IGM (Missing Baryons)
  - ~1.4 -> 3.1
- Nearby SN:
  - ~4.4, -> 9.7
- Accreting MSPs:
  - ~1.4 -> 3.1
- Magnetars/SGR
  - ~2.8 -> 6.2
- X-ray Rich/OD GRBs
  - ~4.8 -> 10.6
- CVs in Outburst
  - ~2.7 -> 5.9
- Bursters Throughout Decay
  - ~1.4, -> 3.1



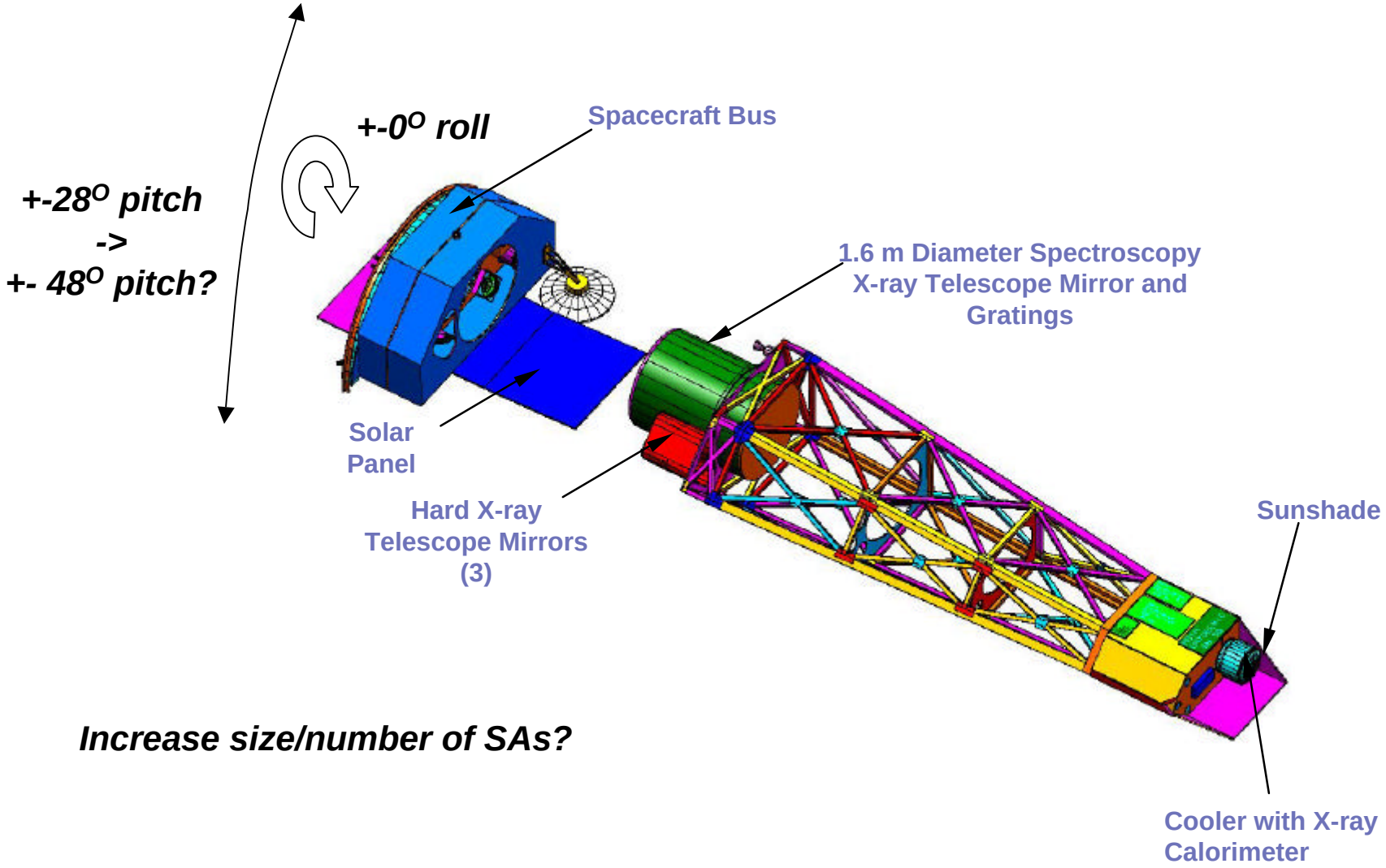
Significant Increase for these rare ToOs with 42% increase in SA size

End of presentation – backup slides follow

Number/Types of ToOs?

- **2: Chandra ToO Observations (not yet in ODRM)**
  - Accreting MSPs (Chakrabarty, Markwardt….)
    - Discovery rate 1/year, Chandra rate 1/year
  - Magnetars/SGR (Kouveltiotu, Woods….)
    - Small population, Chandra rate 2/year
  - Spectra of X-ray Rich/OD GRBs (Piro, Paerels, Garmire, Harrison, Ricker…)
    - Discovery rate high, but Chandra rate (spectra) = 3.5/year
  - CVs in outburst (Mauche, Mukai, Long, Beardmore….)
    - 2.5/year with Chandra
  - Bursters throughout decay – continued accretion (abundances?), heating/cooling of crust? (Bildsten, Wijnands, et al)
    - Aql X-1, RB, NS/XRT, targets limited – Chandra rate 1/year
  - Galactic Nova, Super-Soft Sources, others?

Mission Reference Design



Increase size/number of SAs?